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Utilization of Backwater Habitats by Unionid Mussels (Bivalvia: Unionidae) on the Lower Illinois River and in Pool 26 of the Upper Mississippi River

John K. Tucker, Charles H. Theiling, and James B. Camerer
Illinois Natural History Survey
Long Term Resource Monitoring Program Pool 26
4134 Alby Street, Alton, Illinois 62002, USA

ABSTRACT

Samples of the unionid faunas from two contiguous and five isolated backwaters of the lower Illinois River and Pool 26 of the Upper Mississippi River revealed differences in species composition between the two habitat types. Contiguous backwaters supported diverse faunas (7 to 14 species) near their connections with the river, whereas isolated backwaters supported only three or four species. Species diversity decreased within contiguous backwaters suggesting that the river-backwater interaction is important in maintaining unionid species diversity in these habitats. The common practice of isolating backwaters from the river using levees to prevent siltation may lead to reduced unionid diversity.

INTRODUCTION

Little is known about the extent unionid mussels utilize backwater habitats along the lower Illinois River and the Upper Mississippi River. In the last extensive review of the unionid fauna of the Illinois River, Starrett (1971) reported no unionids from Meredosia Lake, a bottomland lake, one species from Lake Matanzas, a contiguous backwater, and seven species from Quiver Lake, another contiguous backwater. The near absence of information on unionid faunas in backwaters of large rivers stands in sharp contrast to the much more extensively studied faunas of the mainstems of large (e.g., Hornbach et al., 1992; Siemsen, 1993) and small rivers (e.g., Schanzle and Cummings, 1991; Miller, 1993).

Characterizing unionid faunas in contiguous and isolated backwaters is important because some contiguous backwaters such as Swan Lake are candidates or currently scheduled for impoundment as Habitat Rehabilitation and Enhancement Projects (HREPS). Little is known of the effect of such projects on nontarget species such as unionids. Although impoundments of rivers are known to affect mussel faunas (Bates, 1962), no studies have reported species compositions of unionid faunas from contiguous backwaters before and after isolation. With the arrival of the zebra mussel (*Dreissena polymorpha*) in the lower Illinois and Upper Mississippi Rivers (Tucker et al., 1993; Tucker, 1994) complicating conservation of unionid species diversity (Neves, 1993), an understanding of unionid faunal composition in various habitats is critical. Herein, we report on the unionid faunas of Swan Lake and Brick House Slough, both contiguous backwaters, and of five nearby isolated backwaters (Fig. 1).

MATERIALS AND METHODS

We used two collecting methods. Qualitative collections (timed samples) were made by collecting every mussel found in a unit time. Quantitative collections were made by removing all mussels found in 30 randomly placed 0.25 m^2 quadrats at each location (Tucker et al., 1993).

Collecting effort as measured by man hours varied among the stations sampled using qualitative methods. We collected all specimens found in one-half man hour at the Brick House Slough sites (Table 1). We collected all specimens found in two man hours at all other locations (Tables 2 and 3). Because collecting effort differed among stations, the number of individual specimens for all sites are converted to the number of specimens collected for each one-half man hour (Tables 1-3). We made all collections in water shallow enough for wading. Specimens were located by touch.

Quantitative samples were made at Brick House Slough station 1 and Swan Lake station 1 so that more objective comparisons could be drawn between those two locations. Mussels were too infrequent at the interior and isolated stations to employ quantitative sampling.

Collecting areas are outlined in Fig. 1. Swan Lake and Brick House Slough are contiguous with the Illinois and Mississippi Rivers, respectively, whereas all other sites are isolated by levees. We collected at seven stations within Swan Lake and four stations within Brick House Slough. Of the seven stations inside Swan Lake, three of them (1-3) are within 800 meters of the mouth of the lake and are classified as exterior stations, whereas the other four (4-7) are classified as interior stations. Of the four stations in Brick House Slough, two are within 400 meters of the mouth and are classified as exterior stations, whereas the other two (3-4) are classified as interior stations. We made collections at single station in all of the isolated backwaters (= isolated stations). All sampling occurred between 1 July and 22 July, 1994.

We identified all specimens (Cummings and Mayer, 1992) in the field and returned them to the collecting station immediately after identification. Only living specimens are included in the samples.

We used the SAS system of statistical programs (SAS Institute, 1988) for statistical evaluation of results. We selected the GLM procedure, which is appropriate for unbalanced sample sizes, to perform analysis of variance (ANOVA).

RESULTS

Qualitative samples.

We collected a total of 16 unionid species from the 16 stations we sampled. Only one species, *Anodonta grandis*, occurred at every station. Of the remaining species, only *Amblema plicata* (11 of 16), *Quadrula quadrula* (13 of 16), and *Potamilus ohiensis* (9 of 16) were collected at more than half of the stations. Half of the species (8 of 16) were collected at either a single station or two stations. Eight species (*Megalonaias nervosa, Quadrula nodulata, Anodonta imbecilis, Arcidens confragosus, Lasmigona complanata, Obliquaria reflexa, Potamilus alatus,* and *Truncilla truncata*) were collected only at stations we classified as exterior stations in the contiguous backwaters (Tables 1 and 2). The remaining species occurred in two or more station classifications.

We used ANOVA to compare the number of species found in contiguous backwaters (exterior and interior stations) and isolated backwaters as well as the number of specimens found. The model for the comparison of the number of species is significant (mean square = 47.68, $F = 13.58$, $p = 0.0007$) as is the model for the number of specimens (mean square = 14212.11, $F = 11.09$, $p = 0.0015$). For the number of species, exterior stations (mean number of species = 8.8, n = 5) had significantly more species ($p < 0.05$) than did interior stations (mean number of species = 4.2, n = 6) or isolated stations (mean number of species = 3.0, n = 5). Interior and isolated stations did not differ ($p > 0.05$) from each other. Exterior stations also had more ($p < 0.05$) specimens per unit of collecting effort (mean = 105.25 specimens / half-hour) than did either interior stations (mean = 14.58 specimens / half-hour) or isolated stations (mean = 14.0 specimens / half-hour). Again, interior and isolated stations did not differ significantly ($p > 0.05$).

Individual comparisons within station classifications found no statistically significant differences in the number of species between the stations classified as interior stations nor for those classified as isolated stations. The exterior stations for Swan Lake and Brick House Slough did not differ statistically in the number of species (10.3 and 6.5, respectively) found ($F = 2.50$, $p = 0.2120$) but did differ ($F = 13.34$, $p = 0.0354$) in the number of specimens (64.08 and 167.0, respectively) found per half-hour of collecting effort.

Quantitative samples.

The mussel faunas at Brick House Slough station 1 and Swan Lake station 1 are similar in most respects (Table 4). Both are dominated by a few species and in particular by *Amblema plicata*. Likewise, *Quadrula quadrula, Anodonta grandis,* and *Obliquaria reflexa* are important contributors to the faunas. However, we did find significantly more specimens per meter ($F = 4.77$, $p = 0.0330$) at Brick House Slough than at Swan Lake (Table 4) consistent with the results of the qualitative sampling (Tables 1 and 2).

DISCUSSION

The species and number of specimens found in our study vary by habitat. Stations that are near to the river/backwater connection contained more species and larger numbers of individuals. Such stations (e.g., Brick House 1-2 and Swan Lake 1-3) have faunas that are typically riverine. For instance, species lists recently published for the Illinois River near Swan Lake and for the Mississippi River in Pool 26 (Tucker et al., 1993; Tucker, 1994) are similar to the species that we found at stations we classify as exterior ones. However, samples from interior and isolated stations are not riverine and are more similar to other lake faunas (e.g., Parmalee, 1955; Starrett, 1971). Apparently, the interactions at the river/backwater interface is important in maintaining the riverine nature of faunas from exterior stations.

At this point, it should be noted that the number of species collected is related to the collecting effort expended regardless of the technique employed (i.e., Lubinski, 1987). Therefore, statistical comparisons of the number of species collected among sites with differing collecting effort is questionable. However, in this instance, collecting effort was greatest in the locations (i.e., isolated backwaters) with the lowest numbers of species collected. The differences between isolated and contiguous backwater species numbers should be reduced yet species numbers from contiguous backwater samples were still statistically greater than those from isolated backwaters where collecting effort was as much as four times greater. If anything, the difference in collecting effort minimized the differences between isolated and contiguous backwaters.

Although the proximal causes of the differences between exterior stations and interior/isolated stations are not known, the importance of river/backwater interaction is underscored by the change from a riverine fauna to a lentic fauna within both of the contiguous backwaters we studied. The role of contiguous backwaters in transporting resources to the river has been investigated for invertebrates (Shaeffer and Nickum, 1986a) and fish (Shaeffer and Nickum, 1986b). In both instances, the authors have concluded that backwaters export resources to the river; we believe that Swan Lake exports and imports resources between the river and the lake.

Currents in the vicinity of the mouth of Swan Lake have been observed to change direction on a daily basis, probably due to differencial diurnal heating and cooling of the river and backwater. Other water exchanges probably occur due to mechanical eddies in the vicinity of the mouth of Swan Lake. We believe inflowing currents transport resources originating in the river into the lake and it's resident mussels. Outflowing currents likely transport resources originating in the lake over the mussels and out to the river. Both water movement and energy transport are factors assumed to be important in the distribution of unionid species in contiguous backwaters.

Our study has important ramifications where maintenance of unionid species diversity is a consideration in management activities. Programs such as levee construction that isolate backwaters from the river will likely significantly reduce unionid species diversity. Such habitat modification programs are justified by the desire to reduce sedimentation rates and increase numbers of 'preferred' species such as waterfowl and centrarchid fishes.

At present, little concern exists about maintaining unionid faunal diversity within backwaters due in part to the widespread belief that 'better quality' faunas are found in the adjoining channel borders of the two rivers that we studied. The report that contiguous backwaters may serve as refugia from the adverse effects of the zebra mussel, *Dreissena polymorpha* (Tucker and Atwood, 1995), suggests that maintenance of the river/backwater connection may become an important tool for preserving unionid diversity in North American rivers. Prior to the introduction of *D. polymorpha*, the diversity and abundance of unionid mussels had been greatly challenged by human disturbance of their habitats (Starrett, 1971; Lubinski, 1987). For instance, Starrett (1971, Table A-21) reported that 21 species of unionids apparently had been extirpated in the Alton Pool of the Illinois River since 1870. William et al. (1992) found that roughly 55% of North America's mussel species were extinct or endangered. However, the importance of habitat destruction may pale in contrast to the future effects on unionid diversity caused by the introduction of exotic species such as the Asiatic clam, *Corbicula fluminea* (e.g., Belanger et al., 1990; Leff et al., 1990) and the zebra mussel, *Dreissena polymorpha* (e.g., Mackie, 1991; Hunter and Bailey, 1992; Mackie, 1993; Tucker, 1994; Gillis and Mackie, 1994).

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Table 1. Numbers and species of unionids collected from contiguous and isolated backwaters of the Mississippi River including Brick House Slough, the contiguous backwater, and Dresser Island and Spadderdock Lake, the isolated backwaters, for 0.5 manhours of picking.

	Isolated backwaters		Brick House Slough stations			
	Spadderdock	Dresser	1	2	3	4
Species	n	n	n	n	n	n
Amblema plicata	0	1	154	111	10	9
Megalonaias nervosa	0	0	2	0	0	0
Quadrula nodulata	0	0	0	2	0	0
Quadrula quadrula	1	0	7	5	10	3
Anodonta grandis	4	14	2	15	14	10
Anodonta suborbiculata	4	12	0	0	1	0
Arcidens confragosus	0	0	6	0	0	0
Leptodea fragilis	0	0	0	0	0	1
Obliquaria reflexa	0	0	22	2	0	0
Potamilus ohiensis	5	0	0	2	1	0
Truncilla truncata	0	0	4	0	0	0
Number of species	4	3	7	6	5	4

Table 2. Numbers and species of unionids collected in Swan Lake, a contiguous backwater of the Illinois River. Number of specimens (n) collected adjusted to number collected per 0.5 manhours collecting for each site.

	Exterior stations			Interior stations			
	1	2	3	4	5	6	7
Species	n	n	n	n	n	n	n
Amblema plicata	58.50	35.50	34.0	3	0	1	4.25
Megalonaias nervosa	0.25	0	0	0	0	0	0
Quadrula nodulata	0.75	0	0	0	0	0	0
Quadrula quadrula	6.75	3.25	5	7	0.50	2	0.25
Anodonta grandis	10.50	5.25	5.75	3	3.50	0.25	0.25
Anodonta imbecillis	0.50	0.75	0	0	0	0	0
Anodonta suborbiculata	0	0	0.25	0	0	0.25	0
Arcidens confragosus	0.50	0.75	0.50	0	0	0	0
Lasmigona complanata	0.25	0	0.25	0	0	0	0
Lampsilis teres	0.75	0	0	2	0	0	0
Leptodea fragilis	0.75	0.25	0	0	0	0	0
Obliquaria reflexa	8.75	2.25	1.25	0	0	0	0
Potamilus alatus	0.25	0	0	0	0	0	0
Potamilus ohiensis	0.75	0.50	0.50	0	0.50	0.25	0.50
Truncilla truncata	0.50	0	0	0	0	0	0
Toxolasma parvus	0	0	0.75	0	0	0	0
Number of species	14	8	9	4	3	5	4

Table 3. Number and species of unionids collected in three isolated backwaters of the Illinois River. Number of specimens (n) collected adjusted to number collected per 0.5 manhours collecting for each site.

Species	Stump Lake n	Silver Lake n	Gilbert Lake n
Anodonta grandis	8.25	11.50	3.50
Anodonta suborbiculata	0	3.50	1.50
Toxolasma parvus	0.75	0	0
Quadrula quadrula	0	0	0.50
Leptodea fragilis	0	0	0.50
Number of species	2	2	4

Table 4. Number and species of unionids collected in quantitative samples from Swan Lake (station 1) and Brick House Slough. n = total number of specimens collected in 30 0.25 m^2 samples.

Species	Swan Lake n	Brick House Slough n
Amblema plicata	55	103
Megalonaias nervosa	0	3
Quadrula pustulosa	0	1
Quadrula quadrula	11	21
Anodonta grandis	6	12
Anodonta imbecillis	1	0
Arcidens confragosus	1	2
Lasmigona complanata	0	3
Lampsilis teres	8	0
Leptodea fragilis	8	3
Obliquaria reflexa	16	12
Potamilus alatus	2	0
Potamilus ohiensis	2	0
Truncilla truncata	5	2
Number of species	11	10
Number specimens/m^2	15.3	21.6

Figure 1. Upper Mississippi and lower Illinois Rivers showing location of study sites at Stump, Gilbert, and Silver Lakes and collecting stations within Brick House Slough (Detail A) and Swan Lake (Detail B).